46 Chest Examination

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Definition

The patient's history determines the scope and intensity of the chest examination. When the history elicits suspicion of the presence of a chest problem, the physical examination of the thorax must be expanded beyond a minimal screening examination to determine the nature of the problem so that a diagnosis can be made.

Technique

The setting for the chest examination must be environmentally comfortable for both clinician and patient. The physical examination begins with the commencement of history taking. The examiner extends a hand in greeting, asks about the symptoms that initiated the visit, and begins physical inspection, noting body position, assessing degree of comfort, inspecting and palpating the hands, and noting grip strength. The history determines the examination format. Experienced clinicians exploit the history to help them "look" for specific physical findings to answer questions posed by the totality of data collected previously. When using this process, it is unusual for two consecutive chest examinations to be identical. By the time the physical examination is complete, even before laboratory evaluations are initiated, the diagnosis should be reasonably certain.

The pulmonary examination consists of inspection, palpation, percussion, and auscultation. The inspection process initiates and continues throughout the patient encounter. Palpation, confirmed by percussion, assesses for tenderness and degree of chest expansion. Auscultation, a more sensitive process, confirms earlier findings and may help to identify specific pathologic processes not previously recognized.

Inspection

Inspection (Table 46.1) is an active process. It is done with the eyes and the intellect. It begins with the initial greeting and continues uninterruptedly during the entire data collection process. Even as the first serious question of the fully dressed patient is asked, the inspection begins through active observation. Specifically, one must note the dynamics of the patient's facial expression in relationship to physiologic activities (inspiration and expiration) and to the questions asked by the examiner. Similarly, active observation skills are used to search for the use of pursed lips during expiration, the activity and development of the sternocleidomastoid muscles, the use of other accessory muscles of ventilation, the presence of shoulder girdle fixation in relationship to the use of these accessory muscles, the flaring of the nasal alae, the presence of jugular venous distention, the degree of comfort, and, as discussed in previous chapters, the presence of cyanosis and clubbing. Not only may a voluntary smile be helpful in assessing neurologic function, but also inspection of the teeth at that time (even though you are just starting to take the history) may reveal extensive pyorrhea that serves to alert the clinician to a dental problem that has a potential as a bacterial source for necrotizing pneumonia.

As the interview continues, assessment of the level of consciousness and the appropriateness of behavior may lead one to suspect a primary pulmonary process that secondarily produces alterations of central nervous system function. Two examples are respiratory acidosis and cerebral metastases from primary carcinoma of the lung. Dress, too, may give a clue to occupation or hobby, grooming may be related to the conscientiousness with which the patient may follow a health care plan, and a bulging shirt pocket may be stuffed with an open package of cigarettes, an important clue to the possibility of a chest problem.

The inspection continues even though the patient remains fully clothed and the "formal" physical examination has not yet begun. It is often helpful to make an initial assessment of the ventilatory pattern early in the data collection process. Specifically, one should be concerned about rate, rhythm, breath volume, and the apparent effort associated with breathing. Most resting adults breathe about 12 times per minute, not the customary 20 often noted in medical records. Tidal volumes range around 600 ml. Except for an occasional sigh, the normal ventilatory pattern is regular and effortless. In disease this pattern may change.

The assessment of ventilatory pattern during the history does not give the patient an opportunity to alter breathing involuntarily and confound the data. It also allows one to process data earlier and to increase efficiency.

When the "formal" physical examination does begin, the setting is changed. Inspection continues, but with the patient undressed from the waist up, either entirely or sequentially, as drapes are changed to expose only those areas being actively observed. A chaperon should be present when it would make either the patient or the examiner more comfortable.

First, one should observe for thoracic cage deformity (pectus excavatum, pectus carinatum, scoliosis, kyphosis, surgical or traumatic scars, thoracoplasty, gynecomastia, and so-called barrel chest deformity). The presence of some skin lesions may reflect intrathoracic pathology. These are "static" observations. Even more useful information can be obtained as the patient breathes, both quietly and deeply. Such "dynamic" observations include the search for supraclavicular or intercostal retraction, paradoxical movement of the abdomen, any degree of asymmetry or asynchrony of chest expansion, muscle wasting or hypertrophy, and reproducible grimaces of discomfort at a given point in the ventilatory cycle. Other nonmanually elicited data such as audible musical breath sounds—wheezes—strongly influence the decision-making process.

Table 46.1
Inspection

	Minimal examination	Dyspnea	Wheezing	Cough/ expectoration	Hemoptysis	Cigarette smoke	Environmental	Other organ disease
Facial expression:	M							
Nasal alae		I	M					
Pursed lips		M	I					
Pyorrhea				M	M			
Sternocleido-mastoid		I				I		
Jugular venous distention	M		I				I	Right-sided heart failure
Posture:	I							
Fixed shoulder girdle		M	M				I	
Diaphoresis		I	M					
Splinting		M		M	I			Intraabdominal process
Breathing pattern:	I							
Rate	M							
Rhythm	I							Cerebral
Breath volume		I		M			I	metabolic acidosis
Degree of effort		I	M		I	I	I	
Chest configuration								
Static:								
Pectus excavatum								
Spine contour		I						
Surgical scars	I	I	M					
Gynecomastia								I
Barrel chest (↑ A-P diameter)								No clinical significance in adult
Dynamic:								
Expansion	M						I	
Retraction		I	M			I	I	
Paradoxical movement		I						
Muscles		I						Neuromuscular disorders
Grimaces								
Audible wheezes		I	M	M		I		Upper airway obstruction
Skin:								
Spider hemangiomas								Liver
Fibroma								Neurofibromatosis
Acanthosis nigricans								Malignancy
Acne + striae			I					Cushing's disease/ syndrome

I = indicated; M = mandatory.

Palpation

Palpation (Table 46.2) is the next stage of the examination. With the patient disrobed, place the entire palm of each hand first on the superior portion of both hemithoraces and then, gently though firmly, move the hand inferiorly to just below the twelfth rib. Repeat the process moving laterally and subsequently anteriorly; search for rib deformities, nodules, and areas of tenderness. In the face of a history of chest discomfort, ask the patient to point to the area(s) of greatest discomfort. Palpate the area with increasing firmness in an attempt to elicit tenderness and to assess if this maneuver reproduces the patient's symptoms. Pay particular attention to the costochondral junctions in patients reporting anterior chest pain to evaluate the possibility of costochondritis.

Palpation is also important in the assessment of ventilation. One can sensitively assess the symmetry, synchrony, and volume of each breath. This is done by examining the patient posteriorly, placing the examiner's thumbs together at the midline at the level of the tenth rib with hands grasping the lateral rib cage; both visual and tactile observations are made both during tidal volume breathing and during deep forceful inhalation. With the latter, thumbs typically separate by approximately 2 to 3 cm.

A part of the palpatory portion of the chest examination is to assess the position of the trachea. This is accomplished best with the examiner stationed behind the patient, palpating the anterior inferior neck just above the jugular notch by gently pressing the fingertips between the lateral tracheal wall and the medial portion of the sternocleidomastoid mus-

Table 46.2
Palpation

	Minimal examination	Dyspnea	Wheezing	Cough/ expectoration	Hemoptysis	Cigarette smoke	Environmental	Other organ disease
Palpation for cutaneous or subcutaneous nodules								
Soft		I						Neurofibromatoses
Hard				I	M	I		
Palpation for tenderness:								
Costochondral junction		I						Chest pain (M)
Other					I			Chest pain (M)
Assess ventilatory excursion:								
Symmetry	I	I						
Synchrony	I				I			
Expansion	I	M	I				I	
Assess observed abnormalities:								
Gynecomastia		I				I		
Spider hemangiomas								Liver (M)
Position of trachea	I	M		I			I	

I = indicated; M = mandatory.

cle. Comparing one side to the other, an assessment is made of the position of the trachea: midline or deviation away from the centrist position.

Tactile appreciation of vibrations transmitted to the surface of the thorax as upper airways sounds are generated by breathing or speaking is a traditional though insensitive maneuver referred to as tactile or vocal fremitus. Egophony is both more specific and sensitive. It is discussed under auscultation.

Percussion

The purpose of percussion (Table 46.3) is to determine if the area under the percussed finger is air filled (sounding resonant like a drum), fluid filled (a dull sound) or solid (a flat sound). To make this interpretation it is important not only to listen for the sound produced but also to feel the intensity and frequency of vibrations produced by this maneuver.

The technique of percussion is best accomplished by the following approach:

1. Press the distal phalanx of the middle finger *firmly* on the area to be percussed and raise the second and fourth fingers off the chest surface; otherwise, both sound and tactile vibrations will be blunted.
2. Use a quick, sharp wrist motion (like a catcher throwing a baseball to second base) to strike the finger in contact with the chest wall with the tip of the third finger of the other hand. The best percussion site is between the proximal and distal interphalangeal joints. The novice quickly learns to trim the fingernail to prevent personal discomfort of minor abrasions and lacerations.
3. If the sound and the vibrations produced seem suboptimal, make sure that the finger placed directly on the thorax is making very firm direct contact with the chest wall. If not, few vibrations and little sound will be produced.

Table 46.3
Percussion

	Minimal examination	Dyspnea	Wheezing	Cough/ expectoration	Hemoptysis	Cigarette smoke	Environmental	Other organ diseases
General percussion:								
Note over thorax	I	M	I				I	
Identification of focal changes		I	I	I	I			Lymphoma
Diaphragmatic:								
Movement	I	M					I	Myasthenia and other neuromuscular disorders
Asymmetry				M	M	I		
Asynchrony				I	I	I		

I = indicated; M = mandatory.

4. Percuss the posterior, lateral, and anterior chest wall in such a manner that the long axis of the percussed finger is roughly parallel to the ribs. Compare one side to the other.
5. Over each area, begin percussion superiorly and extend inferiorly to identify the level of the diaphragm during quiet (tidal volume) breathing. Note the position of the diaphragm. Then ask the patient to inhale fully and "hold it"; continue to percuss inferiorly to determine the new level of the diaphragm, now during forced maximal inspiration. Then, don't forget to tell the patient to "breathe normally." The difference between the two levels is known as diaphragmatic excursion and should equal 2 to 3 cm.

Auscultation

Auscultation of the chest (Table 46.4) is part of every chest examination but it is the data collected during inspection, palpation, and percussion that alert the clinician what to listen for during auscultation in order to identify the correct diagnosis most effectively.

The stethoscope is an instrument that does not significantly amplify sound, but, more important, acts as a selective filter of sound. Briefly, the bell filters high-frequency sounds greater than 1500 cycles per second and therefore should be used to detect low-frequency sounds. On the other hand, the diaphragm selectively filters low-frequency sounds. Since sounds produced by breathing tend to be of relatively high pitch, the chest is ausculted with the diaphragm.

Auscultation of the chest ideally is performed in a quiet room with the patient either sitting or standing. When the posterior thorax is examined, the patient's arms should be crossed anteriorly to move the scapulas laterally as much as possible. Comparing one side to the other is a helpful maneuver to identify the patient's "normal." Auscultation should be performed during tidal ventilation, deep forceful inspiration, and forceful expiration. It is not only intuitively obvious but rigorously proved that the intensity of breath sounds is related to flow rates; that is, the louder the sound, the greater the flow rate, all other things being equal.

Basic Science

The primary structure of the chest is designed to facilitate ventilation, which can be accomplished only by increasing the intrathoracic volume. This increase is due to elevation of the ribs, contraction of the scalene and intercostal muscles, and descent of the diaphragm. Because of the structure of the ribs, the scalenus muscles elevate the first rib and the sternum anteriorly. This causes slight increase in the anteroposterior (A–P) diameter of the chest. The lower ribs (T6–T12) expand laterally by contraction of the intercostal muscles. The diaphragm, by contracting, elevates the lower ribs superiorly and laterally as well as increases the intrathoracic volume. Any deviation from the normal anatomical relationship of the skeletal system and the associated muscles would be expected to cause some abnormality in the inspiratory cycle of ventilation.

During ventilation, the movement of gas produces sound audible with a stethoscope. Generally, the velocity of gas movement is proportional to the intensity of the sound. Qualitatively, there are three types of "normal" breath sounds: vesicular, bronchovesicular, and bronchial. The three sounds are clearly differentiated by the characteristics of duration, pitch, and intensity (see Table 46.4).

Vesicular sounds are thought to be produced by gas movement through the distalmost portions of lung units. They are low in pitch, predominantly inspiratory in timing, and have a breezy character. Bronchial or tracheal sounds are produced high in the upper airways and trachea. They are often loud and high pitched. The expiratory phase is longer than inspiration and follows a "silent gap." Bronchovesicular sounds are intermediate between the two. Under normal circumstances, air-filled lung units act as high-frequency filters so that the bronchial breath sounds generated in the upper airways are poorly transmitted through air-filled lung. On the other hand, when there is little air-filled lung between airways and the stethoscope, or when lung units are filled with liquid rather than gas, bronchial breath sounds are heard clearly. As a result, bronchial breath sounds are heard normally over the trachea, the upper sternum, and paraspinal areas of the upper thoracic vertebrae. As

Table 46.4
Auscultation

	Minimal examination	Dyspnea	Wheezing	Cough/ expectoration	Hemoptysis	Cigarette smoke	Environmental	Other organ diseases
Breath sounds:								
General	I							
Inappropriate:								
Location of bronchial breath sounds				I				
Abnormal breath sounds:								
Wheezes:		I	M					
General			M					
Local			I		I			
Crackles		I						
Early inspiratory				M	I	M		
Late inspiratory							M	"Collagen vascular diseases"; congestive heart failure
Gurgles		I		I				Pulmonary edema

I = indicated; M = mandatory.

one moves peripherally and more air-filled lung is found between the airways and the stethoscope, breath sounds first become bronchovesicular in quality and eventually vesicular.

As stated above, the intensity of sound is a function of airflow. Careful examination of upper lung fields reveals greater intensity of breath sounds early during the inspiratory phase compared to the sounds generated during inspiration over lower lung fields where the intensity peaks rather late. This is a reflection of the normal physiologic phenomenon that as one inhales from residual volume, the initial bolus of gas enters upper lobe alveoli; and only when these lung units are nearly filled is there bulk movement of gas to the lower lung fields. When there is obstruction to the airways of the upper lobes, this pattern is no longer present.

There are three types of abnormal breath sounds. Frequently, they are collectively referred to as adventitious breath sounds. The most easily recognized abnormal breath sound is the wheeze, a continuous musical sound produced when a critical velocity of gas flow passes through a slitlike opening. The pitch of sound is a function of the compliance of the material producing the slitlike opening, not the original size of the obstructed tube. One may appreciate wheezing over the entire thorax or locally. The other two abnormal breath sounds are noncontinuous in nature. The crackle, often called "rale," sounds like the rubbing of a lock of hair over the ear. In vivo, this sound is produced by the snapping open of previously collapsed lung structures, either airways or alveoli. The timing of crackles, which invariably occur during inspiration, should be noted. This is done by asking the patient to exhale fully and then noting the timing of crackles during the subsequent full inspiratory maneuver. When crackles are heard during the initiation of inspiration, they are called *early* inspiratory crackles. When they occur toward the terminal portion of the inspiratory maneuver, they are referred to as *late* inspiratory crackles. At times, crackling sounds can be heard throughout the inspiratory phase and are called paninspiratory crackles.

The final abnormal breath sound is called a gurgle. It is similar to the sound produced when one exhales through a straw placed in a glass of water. Gurgles are produced by airflow through liquid of varying viscosities in the airways. Since some clinicians use the term *rhonchus* to mean low-pitched wheeze and others use this same term to mean gurgle, it is recommended that confusion be minimized by not using the term rhonchus.

Clinical Significance

Physical findings must be interpreted in light of all previously collected data. The general scheme is to develop a postulate and test it with further history, additional observations or maneuvers on physical examinations, and laboratory tests. For example, a 60-year-old pipefitter with known exposure to airborne asbestos material who never smoked cigarettes and presents with increasing dyspnea and cough would most likely have asbestosis (interstitial fibrosis caused by the asbestos inhalation) if one observed dry, nonproductive cough following every moderate to deep breath; if the same initial data differed because of cigarettes in his pocket and an intermittent cough associated with the expectoration of blood, carcinoma of the lung might head the differential diagnosis list.

Inspection

The respiratory rate may increase with the presence of an interstitial pulmonary process or chest wall restriction, but tidal volume typically remains unchanged. The presence of slow, gasping ventilatory maneuvers is an ominous sign suggesting cerebral hypoxemia.

Dysrhythmic breathing is typified by Cheyne–Stokes respiration. This eponym refers to a periodic pattern of alternating hyperpnea and apnea. Though, at times, it is a normal phenomenon seen in infants, the elderly, and during ascent to altitude, more often it is a reflection of significant cardiac and/or pleural nervous system dysfunction.

Breath volumes are increased without substantial modification of rate as a compensatory mechanism to blunt the effects of a metabolic acidosis such as occurs with uncontrolled diabetes. When this occurs, the effort associated with this Kussmaul breathing seems to be minimal.

The configuration of the chest may aid in the diagnostic process. Typically, pectus excavatum (funnel chest) or its counterpart pectus carinatum (pigeon breast) are associated with unequivocal physical findings but rarely have an adverse impact on pulmonary function. Scars identify previous surgery or trauma and alert the clinician to the need for a complete history of the event. The so-called barrel chest deformity, sometimes referred to as increased A–P diameter, often erroneously is interpreted as associated with the presence of pulmonary emphysema. Several studies have proved that this description is not necessarily associated with underlying pulmonary disease but regularly is a function of weight loss and mild kyphosis, a function of the aging process.

During breathing, assessment of changing chest shape can be more helpful. The presence of intercostal retraction, pursued-lip breathing, and use of accessory muscles suggest airways obstruction. Paradoxical movement of chest and abdominal muscles should alert the clinician to the possible usefulness of pulmonary physiotherapy to improve ventilatory efficiency. Grimaces or other expressions of discomfort occurring at the same point in each ventilatory cycle should influence the examiner to identify the origin of that discomfort more precisely. Finally, wheezing heard by the examiner during tidal volume breathing or exaggerated breathing may be a reflection of upper airway obstruction (stridor) or severe lower airway narrowing. The search for dermatologic abnormalities also may lead one to the identification of other systemic or pulmonary processes.

Palpation

Palpation is used both as a screening technique and as a means to confirm a specific diagnosis. Light palpation over the entire thorax posteriorly, laterally, and anteriorly will aid in the identification of cutaneous and subcutaneous nodules and the site of previously unsuspected tenderness. Nodules that are firm and freely moveable suggest a focal benign inflammatory or clinically insignificant problem. Those that are hard, fixed, and multiple suggest metastatic malignancy. Fleshy nodules may be indicative of a systemic disease such as neurofibromatosis.

Tenderness may be elicited during this same maneuver. At times, it is unsuspected by both the patient and the examiner. Under other circumstances, it is used to aid in a diagnosis of the complaint of chest pain. Localizing a rib fracture, either traumatic or pathologic, or reproducing the chest pain of costochondritis by firm palpation of an inflamed costochondral junction may be most helpful in planning further management. Tenderness over an inflamed or infarcted area of lung may also aid in the localization of the disease process.

Assessment of ventilatory excursion includes evaluation of the synchrony of expansion and the degree of chest expansion associated with a deep forceful inspiration from residual volume. Asymmetrical expansion invariably implies decreased ventilation to one side. This may be due to thoracic wall abnormalities, particularly those that are either associated with structural immobility or defect (thoracoplasty) or pain (rib fracture). Similarly, the problem may be caused by an inflamed, fibrosed, or malignantly infiltrated pleura, a unilateral pleural effusion, an interstitial pulmonary process, or a complete obstruction of an airway or airways on the ipsilateral side. Functional severing of the phrenic nerve or intraabdominal process causing paralysis of the ipsilateral hemidiaphragm may be responsible for asymmetrical expansion. Asynchronous expansion may occur secondary to these processes but usually occurs with functional diaphragmatic impairment or pain.

Palpation is used to assess further abnormalities; gynecomastia suspected because of observed breast enlargement is confirmed by the palpation of breast tissue. Similarly, spider hemangiomas are confirmed when the central arterial supply is seen to feed the spider's radicals following manual occlusion.

Finally, deviation of the trachea to one side can mean that a process is either pulling the trachea to one side, such as occurs with lung volume loss (lobar collapse, atelectasis, pneumothorax), or pushing the trachea away, such as might occur with either a tumor or an inflammatory mass. Spontaneous movement of the trachea in synchrony with the pulse suggests the presence of an aortic aneurysm.

Percussion

Percussion is a major aid in the assessment of ventilatory exertion, the assessment of hyperinflation, and the presence of focal thoracic disease.

The general percussion over a hemithorax can give a clue as to the presence or absence of a pulmonary process. When the percussion note is hyperresonant, one can postulate that the lungs are hyperinflated, such as may occur with emphysema or during so-called air trapping seen in patients with acute asthma. This may also occur in patients with an acute spontaneous pneumothorax. Dullness to percussion, particularly associated with the presence of a high, poorly moving diaphragm, is likely to be associated with a restrictive ventilatory defect if the findings are bilaterally symmetrical. Usually this is associated with an interstitial pulmonary process that can be further evaluated by the presence or absence of late inspiratory crackles on auscultation. Flatness to percussion suggests the virtual absence of air directly beneath the percussed finger and may reflect either fluid in the pleural space (pleural effusion, empyema), solid material in the pleural space (fibrothorax, mesothelioma), or atelectases.

Auscultation

Bronchial breath sounds may be either normal or abnormal. When they are heard on the periphery, where vesicular breath sounds are normally heard, one can imply that the airways to the lung units are open but that the lung units themselves are filled with liquid-like material. When this occurs without pleural fluid, the bronchial breath sounds are loud; when consolidation is associated with a pleural effusion, the bronchial breath sounds are present but often quite decreased in intensity. Confirmation of the presence of bronchial breath sounds can be obtained by listening for egophony ("E to A" sound). This sound is elicited by asking the patient to say the letter "E" as one listens over the suspicious area with the stethoscope. When consolidation is present, the spoken "E" sound is converted to an ausculted "A" sound, similar to that produced by a bleating goat.

In addition to assessing the quality of breath sounds, it is also important to assess the duration of the expiratory phase. Timing the duration of expiratory sound while listening with the diaphragm over the trachea during a forced expiratory volume maneuver is used to identify airways obstruction. Expiratory sound should terminate within 6 seconds. If the sound is prolonged, airways obstruction manifested by an FEV_1 of less than 1.5 liters can be assumed.

Auscultatory wheezes imply the presence of slitlike openings through which a critical velocity of gas is passing. When wheezes are local, one must consider external compression of an airway. Enlarged lymph nodes and tumors do this. A lesion within the airway, such as an endobronchial malignancy or foreign body, also can produce a localized wheeze. Diffuse wheezing is present in inflammatory processes such as bronchitis (both acute or chronic), contraction of hypertrophied bronchial smooth muscle as seen in asthma, inspissated thick secretions of pneumonia, and airway collapse associated with the dynamic compression of pulmonary emphysema.

Crackles imply the snapping open of airways or alveoli. Since larger airways open first as inhalation progresses from residual volume, early inspiratory crackles imply large airways disease while late inspiratory crackles either mean small airways problems (less than 2 mm) or poorly compliant alveoli walls such as seen in congestive heart failure, pulmonary fibrosis, or other interstitial pulmonary processes.

Gurgles suggest fluid in the airways. This may be produced by excessive serous secretion in alveolar cell carcinoma, infected purulent secretion of acute or chronic bronchitis or bronchiectasis, or transudated fluid entering the airways from the alveoli as occurs in pulmonary edema.

References

Forgacs P. Functional significance of clinical signs in diffuse airway obstruction. Brit J Dis Chest 1971;65:170.

Kilburn KH, et al. Anterior–posterior chest diameter in emphysema. Arch Int Med 1969;123:379.

Leblanc P, et al. Breath sounds and distribution of pulmonary ventilation. Amer Rev Resp Dis 1970;102:10.

Lehrer S. Understanding lung sounds. Philadelphia: W.B. Saunders, 1984.

Nath AR, Capel LH. Inspiratory crackles—early and late. Thorax 1974;29:223.

Pierce JA, Ebert RB. The barrel deformity of the chest, the senile lung and obstructive pulmonary emphysema. Amer J Med 1958;25:13.

Rales, rhonchi, and Laennec, recorded by A. John Robertson, after an evening with Robert Coope. Lancet 1957;2:417.